

DEVELOPING METHODS

Goal: Increase effective methods available for wildlife damage management.

BIRD RESEARCH PROGRAM

Project Title: Economic Impact and Management of Bird Predation at Aquaculture Facilities in the Southeastern United States

Goal: Determine the magnitude of and develop methodology to reduce damage by cormorants, wading birds, and pelicans on southern catfish, baitfish, and crawfish farms.

Fish-eating birds can have a substantial economic impact on aquacultural production. Annual costs associated with bird damage and damage prevention for aquaculture industries are estimated to exceed \$17 million. Double-crested cormorants, American white pelicans, and several wading birds are the predominant species associated with these conflicts. In addition to conflicts with aquaculture, double-crested cormorants have also been associated with habitat changes throughout North America. Present NWRC aquaculture research is aimed at acquiring information regarding the abundance, foraging behavior, economic impacts, and damage-management techniques associated with fish-eating birds near southeastern aquaculture facilities. Because these birds annually migrate from northern breeding areas to southeastern wintering grounds, the Center's research efforts should provide the information necessary to develop and evaluate management alternatives for fish-eating birds throughout their range.



The Potential for Fish-Eating Birds To Serve as Hosts of Catfish Parasites—

Catfish aquaculture is an important industry in the Southeastern United States. As with other types of agriculture, environmental factors, disease, and wildlife can impose economic hardships on individual producers and the industry as a whole. Two of the primary causes of economic loss in commercial channel catfish production are losses to diseases and parasites and losses to fish-eating birds. NWRC biologists collaborated in 2004 with the Mississippi State University College of Veterinary Medicine to characterize the life stages of an important catfish parasite, the *Bolbophorus* trematode.

A graduate student working with the College of Veterinary Medicine and a biologist at the NWRC Mississippi field station infected American white pelicans with *Bolbophorus metacercariae* from infected catfish. After subsequent trematode infections were established, trematode eggs were collected from pelican feces and used to infect snails, an intermediate host of the trematode. Free-swimming larval forms (Cercariae) shed from these infected snails were used to infect parasite-free catfish. Larvae in the infective stage (metacercariae) from these infected catfish were then fed to trematode-negative pelicans and allowed to mature to the adult stage. Parasitologists then isolated adult trematodes from the small intestine of the pelicans, completing the parasite's life cycle.

The results of this research provide important information on the parasite's life cycle, evidence that *Bolbophorus damnificus* is a separate species from similar trematodes, and further evidence that this parasite is the causative agent responsible for trematode-related catfish mortality in the Southeastern United States. A followup study initiated in 2004 validates the findings of earlier studies and indicates that, of the birds tested (great blue herons, double-crested cormorants, great



egrets, and American white pelicans), only American white pelicans served as a host of the *Bolbophorus* trematode.

Impacts of Cormorant Foraging Activities in Different Catfish Production Systems—Recent changes in the aquaculture industry have resulted in changes in production systems and dominance of multiple-batch

farming. This type of aquaculture involves growth of multiple size-classes of fish simultaneously in the same pond and periodic harvest of market-ready fish. NWRC scientists have initiated research to address these production changes and characterize the impacts of foraging by captive double-crested cormorants on channel catfish in multiple-batch cropping systems. These data will be combined with results of a study to determine the distribution and abundance of double-crested cormorants on catfish aquaculture in the Mississippi alluvial valley. NWRC scientists will integrate the results of these studies of cormorant habitat-use patterns with detailed studies of foraging impacts to investigate the potential for economic impacts from cormorant depredations and suggest management strategies to alleviate the damage.

Evaluating Management Strategies for Reducing Cormorant Damage to Natural Resources—

In fall 2003, WS was granted expanded authority through new migratory bird management regulations to manage double-crested cormorants that impact aquaculture and natural resources. To ensure that wildlife



managers understand the implications of various management strategies, NWRC biologists are working with the WS operational program to determine how cormorants alter their behavior under different management regimes.

Biologists from the NWRC Mississippi field station continued work initiated in 2003 in New York to evaluate cormorant response to numerous nonlethal dispersal techniques aimed at discouraging these birds from using Oneida

Lake before and after breeding, thereby reducing impacts to recreational fisheries.

NWRC biologists, WS Operations biologists, and Michigan Department of Natural Resources biologists initiated a similar study in the Les Cheneaux region of Michigan in 2004 in response to localized depletions of harvest-sized yellow perch. These biologists are collecting information on perch populations, cormorant habitat use, and cormorant reproductive parameters in specific bodies of

water where perch problems have persisted. Information on these parameters will be combined with new research results on cormorant diet patterns and cormorant behavioral response to specific management strategies, including egg-oiling, nest destruction, and limited control of adult cormorants. These studies will help determine the role of cormorants in perch depletion and whether cormorant management can effectively reverse the depletion trends.

Project Title: Develop New or Improved Uses of Vulture Effigies and Population Models To Reduce Vulture Damage to Property, To Control Predation on Livestock, and To Disperse Nuisance Roosts

Goal: Develop practical, effective uses of taxidermic and artificial effigies to manage predation, aviation safety, and property-damage problems caused by black and turkey vultures. Examine population genetics and modeling as means to evaluate vulture responses to lethal control.

Vulture populations are increasing nationwide, particularly in the Southeastern United States. As vulture numbers increase, so do conflicts with human activities. Black vultures, for example, damage vinyl, plastic, and other synthetic construction and insulation material. Additionally, black vultures prey on newly born livestock and, in association with turkey vultures, form roosts that not only are nuisances (e.g., they can cause electric power outages) but also contribute to human health and safety problems. Vultures often forage at landfills, which in turn are often located near airports. In their daily flights to and from landfills to feed, vultures constitute a major hazard to aircraft. Problems related to vulture management show no sign of diminishing, and the need for efficient, practical, and safe methods of managing vulture damage situations is acute.



Monitoring Black Vulture Use of

Livestock Operations—During February through April 2004, biologists at the NWRC Florida field station worked with WS personnel in Virginia to document black vultures' use of livestock operations in the vicinity of a large winter roost in Radford, VA. This effort involved trapping and tagging 200 black vultures and also fitting 20 of these birds with radio transmitters. Biologists then quantified vulture activity at four livestock operations before and after the large roost in Radford was dispersed using lasers and vulture effigies.

Postdispersal monitoring continued for 2 months, during which 125 of the 200 tagged birds were sighted again at least once, some as far as 40 km from the original location. The telemetry data and the visual observations of tagged birds indicated that vulture activity was not affected by the dispersal of the Radford roost. This was due in large part to the availability of nearby alternate vulture roost sites that were documented in this study.

Dispersal of Vultures From Towers

Using Artificial Effigies—In 2004, biologists at the NWRC Florida field station successfully tested an artificial vulture effigy at

three tower sites in north-central Florida. Daily counts of vultures on the structures before effigy installation averaged 91 birds. After several days of documenting vulture numbers on the towers at sunrise, the biologists installed an artificial effigy obtained from an Internet Web site. The effigy was a 38-cm-tall decorative bird, made with feathers glued to a hard foam body, with a plastic raptor-like head and feet.

Daily counts averaged 15 vultures with the effigy in place, a reduction of 84 percent. Similar levels of success have been obtained previously in dispersing vultures from tree roosts in residential settings.

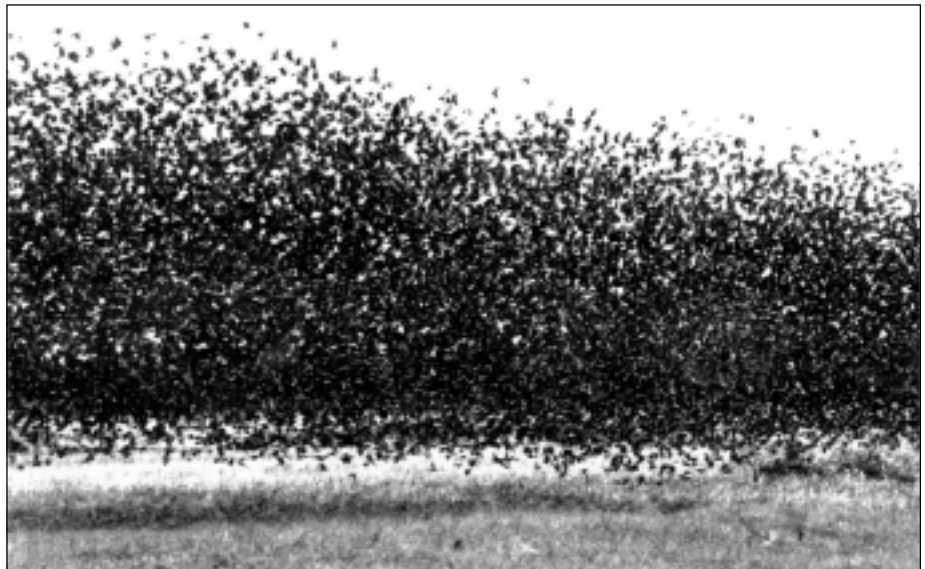
Project Title: Management of Bird Damage to Rice

Goal: Develop new or improved management strategies for reducing bird damage to rice.

Red-winged blackbirds, common grackles, and brown-headed cowbirds cause extensive damage to newly planted rice and ripening rice. NWRC researchers are focused on reducing bird damage to rice and improving profitability to growers by developing new or improved management strategies and expanding partnerships between rice producers, rice commodity groups, rice research boards, universities, and local, State, and Federal agencies.

Potential Blackbird Repellants for Rice

Evaluated—Scientists at NWRC in Fort Collins conducted a series of screening tests to evaluate GWN-4770, a registered fungicide product from Gowan Company, as a potential repellent for reducing blackbird damage to newly planted seed and ripening rice. In one-choice tests, rice consumption of 1 percent GWN-4770-treated rice by blackbirds was reduced more than 90 percent over the 4-day test period compared to a control group.



In no-choice tests, a reliable dose-response relationship was observed among treatment groups associated with the following concentrations of GWN-4770: 0.25, 0.5, 0.75, 1.1, and 2.2 percent. Compared to the pretest

period, rice consumption by blackbirds of 1.1-percent and 2.2-percent GWN-4770-treated rice was reduced 37 percent and 78 percent, respectively.

In addition, Aza-Direct™ and orange citrus terpene were evaluated under the same test design. Neither compound was effective in reducing blackbird consumption of treated rice.

A small-scale field test to evaluate the effectiveness of GWN-4770 and caffeine as blackbird repellants for rice was conducted near Gueydan, LA. Each compound was evaluated on 6 test sites that had intermediate blackbird activity, with about 100 to 200 blackbirds per site. Blackbird consumption of rice treated with 2-percent GWN-4470 and 1-percent caffeine was less than within control plots. Blackbird abundance was less on treated plots than on control plots among all sites associated with the caffeine treatment.

In addition, NWRC scientists cooperated with researchers from the Southeast Missouri State University to evaluate GWN-4770 as a seed treatment to reduce blackbird damage to drill-planted rice seed at the Missouri Rice Research farm near Malden, MO. Researchers planted 12 test plots, 6 of which were planted with 1-percent GWN-4470-treated rice and 6 with untreated rice.

At the conclusion of the test, there was no difference between the number of rice seedlings under wire enclosures and in uncovered assessment sites adjacent to the treated plots. Also, there was no difference between the number of rice seedlings under enclosures in the treated and control plots. However, blackbirds damaged more than 50 percent of the rice seedlings in assessment sites adjacent to enclosures in the control plots.

Although not effective for rice seed treatment, GWN-4770 and caffeine merit further testing as potential blackbird feeding deterrents for sprouted rice and ripening rice.

DRC-1339 Toxicity Tests—NWRC scientists have conducted more research on DRC-1339 than on any other avicide in the United States. This product has gone through the extensive testing required for registration with the Environmental Protection Agency (EPA) and has been used operationally in this country since 1967. Most acute oral toxicity testing of DRC-1339 in blackbirds has been conducted on small samples of red-winged blackbirds. No data previously existed on brown-headed cowbirds or great-tailed grackles. To strengthen the acute oral toxicity database on DRC-1339 used on blackbirds, NWRC scientists conducted toxicity tests that met EPA's current standards, which are based on 10 birds per each of 5 levels. Dose-response curves showing the range from LD₀ to LD₉₉ were developed for brown-headed cowbirds, red-winged blackbirds, and common grackles. The LD₅₀s for brown-headed cowbirds, red-winged blackbirds, and common grackles are 1.8, 2.5, and 0.7 mg/kg, and the LD₉₉s for the same species are 3.1, 3.6, and 3.7 mg/kg, respectively. The data from this study are a key component for developing a predictive model to estimate the take of blackbirds from DRC-1339 baiting operations.

Predictive Model Will Estimate the Mortality of Blackbirds From DRC-1339 Operational Baiting in Louisiana, Texas, and Missouri—Information is lacking for estimating the mortality of target blackbirds from DRC-1339 baiting operations. The number of rice grains actually consumed by blackbirds at DRC-1339 bait sites is not well documented but is a key factor in determining the consumption rate of birds using these sites.

From 2000 through 2004, NWRC scientists collected 2,781 blackbirds as they were leaving several bait sites in Louisiana, Texas, and Missouri. The esophagus and gizzard contents of each bird were analyzed to determine how many rice grains the bird had consumed. In all,

1,984 red-winged blackbirds, 658 brown-headed cowbirds, 138 grackles (common, boat-tailed and great-tailed), and 1 yellow-headed blackbird were collected.

On average, blackbirds visited bait sites for less than 5 minutes before departing to another foraging area. Some birds had eaten no rice at all. Red-winged blackbirds consumed up to 205 rice grains and averaged 31/bird. Brown-headed cowbirds consumed up to 204 rice grains and averaged 41/bird. Grackles consumed up to 265 rice grains and averaged 51/bird.

A model will be developed using a combination of parameters such as bait concentration, toxicity, bait consumption, bait dilution rate, and species composition to estimate blackbird mortality during DRC-1339 baiting operations.

Colorimetric Method Determines Presence of DRC-1339 in Blackbirds—

The current analytical method for determining the presence of DRC-1339 residues in birds, specifically blackbirds, can be time consuming, and the number of samples that can be processed at one time is small. In many cases, researchers only need to know if DRC-1339 is present or absent in a target bird. NWRC scientists developed a simple colorimetric method that can be used in the field to disclose the presence of DRC-1339 in gizzard contents of birds. The presence of DRC-1339 in a processed solution creates a reaction causing the solution to turn from clear to pink at a low DRC-1339 concentration and to bright red at higher DRC-1339 concentrations.

The method is 100-percent reliable for determining the presence of DRC-1339 in blackbirds collected within 30 minutes of consuming a DRC-1339-treated rice bait. A technician can analyze about 50 samples in an 8-hour period, whereas only about 7 samples can be analyzed under the current DRC-1339 residue method in that timeframe. The utility of

the colorimetric method allows researchers or operations personnel to validate the expected number of target and nontarget birds that consumed at least one treated rice grain from a DRC-1339 bait site.

Economic Impacts of Blackbirds on Rice

Rice—The Louisiana Rice Research Board and the Rice Foundation funded a study in 2003–04 to estimate the economic impacts of blackbirds on newly planted and ripening rice in Louisiana, Texas, Arkansas, California, and Missouri. Survey areas in rice-producing States were identified based on the National Agricultural Statistics Service's rice harvest records. NWRC scientists developed a questionnaire to survey rice operators to determine the extent of bird damage, bird species responsible for damage, economic loss, and

associated costs to reduce bird depredations. Questionnaires were sent to 5,833 rice operators. Of those, 969 returned the questionnaire, representing 178,343 ha of croplands.

Overall, 62 percent of the operators that farmed rice in 2001 reported damage from birds, specifically from blackbirds. Those operators reported blackbird damage to 23,526 ha of newly planted rice and 39,104 ha of ripening rice. The total production loss of 25,705,300 lb of rice at 2001 prices is valued at \$1,490,907. In addition, 56 percent of the rice operators reported bird damage in previous years starting with 1996.

Blackbirds were identified as the species causing the most damage to newly planted rice and ripening rice. For all States, about 67 percent of the operators reported that blackbirds

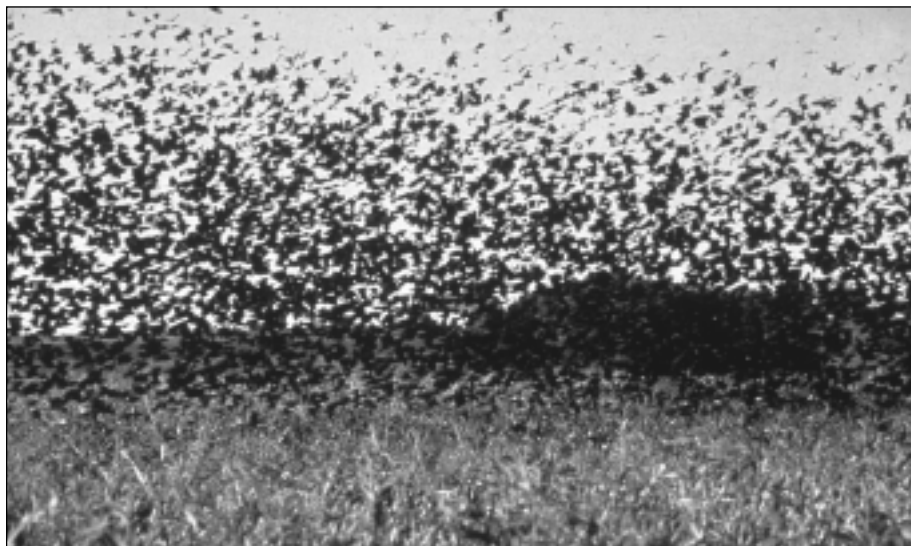
caused the most damage to ripening rice, ranging from 6 to 14 percent. Arkansas operators reported the highest damage to ripening rice. Blackbird damage to newly planted rice for all States ranged from 6 percent to 15 percent. Louisiana operators reported the highest damage to newly planted rice.

Rice operators (503) who responded to questions regarding bird control spent \$633,154 to prevent bird damage to their rice, or about \$1,259 per operator. Roughly 6 percent of the operators spent more than \$4,000 on hazing birds from their rice. Shooting and propane cannons were the most widely used methods for bird control. Of interest were the responses from rice operators to a question regarding WS. Of 744 rice operators from all States, only 231, or 31 percent, had heard of USDA-WS.

Project Title: Development and Evaluation of Management Techniques for Reducing Blackbird Damage to Ripening Sunflower Crops and Feedlots

Goal: Develop new and/or improved methods to reduce blackbird damage to ripening sunflower crops and feedlots.

Blackbirds and starlings are responsible for damaging grain crops and sunflowers and eating livestock feed. NWRC investigators are evaluating the efficacy and environmental impacts of using DRC-1339 to reduce blackbird and starling populations and nonlethal repellent techniques to reduce their damage to crops. Population models on blackbird distribution and abundance and a database on the basic ecology and regional movements of blackbirds in relation to sunflower and livestock feed damage are also being developed.



Wildlife Conservation Sunflower Plots as a Dual-Purpose Wildlife Management Strategy—

The National Sunflower Association has identified blackbird damage as a key reason for growers to abandon planting sunflowers. In the 1980s, NWRC scientists showed that “decoy” plantings of sunflower can significantly reduce bird damage to nearby commercial sunflower fields. For a variety of reasons, largely logistical and economic in nature, decoy sunflower fields did not become widespread. Over the last decade, new Federal farm programs have placed more emphasis on wildlife conservation. Thus, decoy sunflower fields planted to ameliorate blackbird damage and establish habitat for wildlife, especially migratory birds, might garner broad support from both agricultural and conservation groups.

To quantify avian use of sunflower fields, scientists randomly selected 12 oilseed variety sunflower fields and visited these fields 7 times from 22 August to 11 October, 2003. Scientists observed 49 nonblackbird species in or over the sunflower fields. Of those 49 species, 61 percent were granivores, including 16 species of sparrows and 3 species of finches. Granivores made up 74 percent of all birds counted in both the field and field edges. Of 2,159 birds recorded in sunflower, 66 percent were granivores, 21 percent were insectivores, and 10 percent were unidentified. The most common birds were song sparrows, grasshopper sparrows, clay-colored sparrows, dark-eyed juncos, and savannah sparrows. Thus, these preliminary data on avian use of ripening sunflower fields support the notion of Wildlife Conservation Sunflower Plots as a broad-based dual-purpose wildlife management strategy.



Influences of Land-Use Patterns on Blackbird Abundance in the Prairie Pothole Region of North Dakota—

Crop depredation by blackbirds in the upper Great Plains of North America is an issue affecting many sunflower growers. In this region, blackbirds annually destroy an average of \$5.4 million worth of sunflower crops.

To increase the understanding of how blackbird populations are influenced by large-scale land-use patterns, NWRC scientists developed multiple-regression models. Data from the North American Breeding Bird Survey and the U.S. Geological Survey's land-cover assessment were used to develop regression models examining associations between land-use characteristics and blackbird abundance. Both red-winged blackbirds and yellow-headed blackbirds were negatively associated with the amount of developed land, while the amount of wetland strongly influenced yellow-headed blackbird abundance. Common grackles were positively associated with the number of land-use types in the landscape.

These associations can be partially explained by habitat preferences of these species; however, many variables that would seem to be good predictors of blackbird abundance proved not significant. This result suggests that either a greater number of samples is needed to identify these associations or the relationships in question are not detectable at the landscape level.

Avian Use of Roadside Habitat in the Southern Drift Plains of North Dakota and Implications of Cattail Management—

NWRC scientists determined avian use of roadside rights-of-way to develop proper management strategies for the manipulation of roadside cattail. Cattail management is a technique used to reduce nesting and roosting habitat for problematic blackbird species, which might feed on sunflower crops in the vicinity of cattail-dominated wetlands.

Roadside habitat along 2 half-mile (≈ 0.8 -km) transects bordering 30 quarter sections (1 quarter section ≈ 64.75 ha) located in the Southern Drift Plains of North Dakota were surveyed to assess avian use. Additionally, nest surveys were conducted to provide an index of breeding-bird use of this roadside habitat. Finally, roadside habitat was surveyed for a number of different habitat variables.

Forty-nine different species of birds were found during the surveys. Of the 2,529 birds found in this habitat, 1,479 (41.5 percent) were blackbirds. Blackbirds were also the primary nesting birds, contributing to 89 percent of the active nests found in roadside habitat. In terms of avian use and nesting, blackbirds, especially redwings, were the dominant bird species using roadside cattail.

Proper management of roadside habitat can minimize potential effects on nonblackbirds while at the same time reducing the acreage of nesting habitat for blackbirds. These data indicate that a reduction in nesting habitat along roadsides could result in fewer blackbirds and a subsequent reduction in sunflower damage.

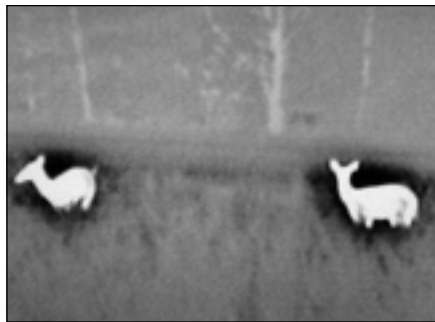
Project Title: Defining and Reducing Wildlife Hazards to Aviation

Goal: Provide a scientific foundation for WS programs at airports throughout the United States to reduce wildlife hazards to the aviation industry.

To be certified for passenger traffic by the Federal Aviation Administration (FAA), most U.S. airports are required to have wildlife hazard-management plans in place. In addition, the FAA has strict standards regarding the capabilities of aircraft engines to withstand bird strikes and the siting of wildlife attractants, such as waste-management facilities, near airports. An interagency agreement between NWRC and the FAA was established in 1991 to provide the FAA with scientific support for recommendations and policies to control wildlife hazards to the aviation industry. These wildlife hazards are primarily caused by federally protected bird species, although certain mammals (e.g., deer) can also be a problem. Research and information needs cover a broad spectrum of topics related to understanding the nature of wildlife hazards at airports, developing management tools that will reduce these hazards, and providing airport personnel with information on the latest strategies for controlling wildlife hazards.

Use of FLIR (Forward-Looking Infrared) To Census Wildlife

Traditional offroad transect surveys for moderate-size mammals sometimes suffer from observer disturbance of the target species, causing flight or even attraction to the observer. Either effect can bias the data necessary to accurately estimate animal population densities. In addition, both aerial surveys of white-tailed deer and night-



time sharpshooting of deer on airports to remove hazards to aviation rely on human perception of animals against natural backgrounds.

Recently, researchers at the NWRC's Ohio field station evaluated FLIR imaging against traditional night-time sighting methods (e.g., spotlights and night-vision technology) to survey white-tailed deer and found the FLIR technology to be superior. Infrared technology allows an observer to discern target animals against background vegetation, an improvement over traditional sighting methods. The researchers also introduced the FLIR technology into vehicle-based line-transect survey methodology to estimate raccoon population density. WS biologists now use FLIR in the airport environment for deer and small-mammal censuses and removal, and in wildlife disease-related efforts.

Evaluation of ElectroBraid™ Fencing as a White-Tailed Deer Barrier

White-tailed deer populations continue to increase, resulting in direct threats to public safety and greater agricultural losses. Various fencing methods are used to reduce deer presence at airports and agricultural areas. Electric fences might offer a less expensive alternative to expensive woven-wire fences. Scientists tested an electric fence product, ElectroBraid™, on free ranging deer during winter months in northern Ohio.

In all tests, deer intrusions into a feeding trough of corn were reduced from 57 to 99 percent, depending upon the experience of the deer with the fence. Those deer that penetrated the fence did not touch their nose or ears on the fence. The size of the enclosure, which ranged from 25 to 2,000 m², did not influence the rate of intrusions. Under the conditions of the test, the ElectroBraid product provided an effective and economical deer barrier.

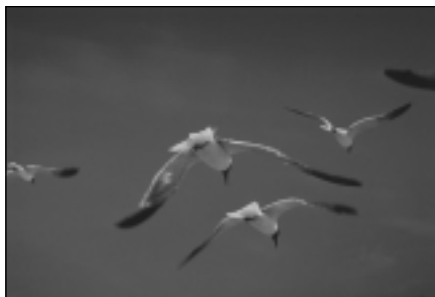


WS Program Effectively Reduces Gull Strikes at John F. Kennedy International Airport (JFKIA)

—In 2003, WS successfully completed its 13th year of providing assistance to the Port Authority of New York and New Jersey at JFKIA. As part of an integrated wildlife damage-control program, biologists have removed more than 68,700 laughing gulls and more than 9,100 other gulls over the life of the project. This joint operational and research program has been very successful in reducing gull–aircraft collisions at JFKIA. Laughing gull–aircraft collisions have been reduced by 76 to 99 percent annually compared with the baseline years of 1988–90. Aircraft collisions with other gulls were reduced by 48 to 76 percent at the same time.

The nearby laughing-gull nesting colony located in Jamaica Bay, which increased from 15 to 7,629 nests from 1979 through 1990, has declined by 71 percent during the years that WS has been removing birds over the airport, to 2,195 nests in 2003. An annual shooting program at JFKIA, although effective in reducing the number of gull–aircraft collisions, has not eliminated the nearby nesting colony or caused a decline in the regional laughing-gull population.

Although this program has been extremely successful, JFKIA must continue improving its integrated management program to minimize strikes by gulls and other bird species. As part of this effort, NWRC scientists began a study in 2003 to understand the feeding habits and the temporal patterns in food selection of the gulls that should provide insight into their movement patterns. Laughing gulls leaving the nearby nesting colony on Jamaica Bay Wildlife Refuge often fly directly across JFKIA, presumably to feeding areas throughout metropolitan New York City or potentially on the airfield



itself. If laughing gulls are feeding on certain insect species on the airfield, it might be possible to remove those resources to deter gull foraging.

Stomach-content analysis was conducted on 470 laughing gulls collected during the 2003 gull strike-reduction program. Invertebrate resources in various habitats on JFKIA were sampled weekly from May to September of 2003. Preliminary findings from this study suggest laughing gulls associated with the Jamaica Bay nesting colony utilize a variety of forages. Foods of marine (e.g., horseshoe crab eggs), terrestrial (e.g., insects), and anthropogenic (e.g., french fries) origin comprised 62 percent, 22 percent, and 16 percent, respectively of laughing-gull diets.

Endophyte-Infected Tall Fescue May Provide a Tool for Airport Vegetation Management—Habitat management is the most effective long-term method of reducing



the attractiveness of airfields to wildlife that present hazards to aviation. Planting vegetation mixtures that are unattractive to wildlife should reduce the risk of damaging bird strikes. In 2003, NWRC scientists completed a study begun in 2000 to examine foraging preferences of Canada geese.

In 2000, replicate plots of two vegetation mixtures, one predominantly endophyte-infected tall fescue and the other predominantly perennial ryegrass, were planted in six replicate plots. Experimental observations of the behaviors of captive Canada geese in these plots, especially foraging, were conducted July–August 2001. Canada geese showed no preference between the two vegetation types when loafing or feeding during 2001.

The vegetation plots were allowed to establish themselves further during 2002–03, and the Canada goose foraging-preference tests were repeated July–August 2003. After 3 years, the tall-fescue plots were well established (mean of 91 percent tall-fescue cover) and provided an excellent opportunity to study the preference between the two vegetation mixtures by Canada geese.

During 2003, captive Canada geese fed almost exclusively in the perennial ryegrass mixture plots and avoided feeding in the tall-fescue plots. This study suggests that endophyte-infected tall fescue might be a favorable species for airfields and other areas where Canada geese are unwanted.

Project Title: Enhancing the Effectiveness of Nonlethal Avian (blackbird/starling) Repellants and Mammalian (skunk/raccoon) Attractants

Goal: To better understand the factors that modulate learning and memory in order to improve the effectiveness of currently available avian repellants and to develop chemical attractants specific to skunks and raccoons.

Despite considerable demand for nonlethal methods of wildlife damage management, few effective chemical repellants and selective attractants exist for most applications. Fundamental physiological data concerning olfaction, taste, and trigeminal chemoreceptive abilities of wildlife are largely nonexistent, and the application of existing behavioral data to enhance wildlife control technologies is lacking. This project investigates the chemosensory morphology, histology, and physiology of sensory system function in several wildlife species important to the WS program.

Testing of Natural Products To Repel Starlings—In a collaborative effort between a scientist at a New York university and the NWRC Philadelphia field station, testing was conducted on a new product comprised of woodchips infused with garlic oil. Laboratory studies indicated that the product repelled European starlings from food in one-choice tests. Additional research is necessary to determine whether the laboratory findings can be extended to new situations. Additional studies with different species of birds and in field settings will be undertaken in 2005.

Other research continues to examine the suitability of new materials, particularly secondary plant compounds, for use as avian repellants.



At the same time, new ways of applying these compounds are being explored. One new strategy is to encase plant compounds in dead yeast cells. This packaging may allow delivery of repellants into the gastrointestinal tract, which in some cases (such as with methyl anthranilate) would allow the repellant to function secondarily. Secondary repellants are those that cause malaise; these are known to be much more effective than primary repellants, which cause irritation, such as chili peppers for humans.

Repellants May Become Ineffective With Overuse

—A collaborative study between the NWRC Philadelphia field station and Monell Chemical Senses Laboratory produced data showing how repellants might become ineffective as a result of overuse. The results show that, as more habitat patches are treated with a repellant, its efficacy disappears completely. This situation has potentially important practical implications for the use of repellants in the field. Further research will test the effect of abundance on consumption of foods treated with secondary repellants.

Starlings Can Detect Conspecific

Odors—Earlier studies conducted by NWRC scientists revealed that the chemosensory systems of birds (taste and smell) are as sensitive as those of many mammals, such as rats and mice. More recently, research has found that starlings can detect odors from conspecific organisms (those belonging to the same species). The area of avian chemical communication research is new, and the significance of such research results has yet to be exploited. These results highlight the importance of an untapped sensory modality in birds that might be a target for future repellants or attractants. The next phase of the project will be to determine if birds detect predator odors such as cat urine, and if so, whether these odors are aversive to birds.